

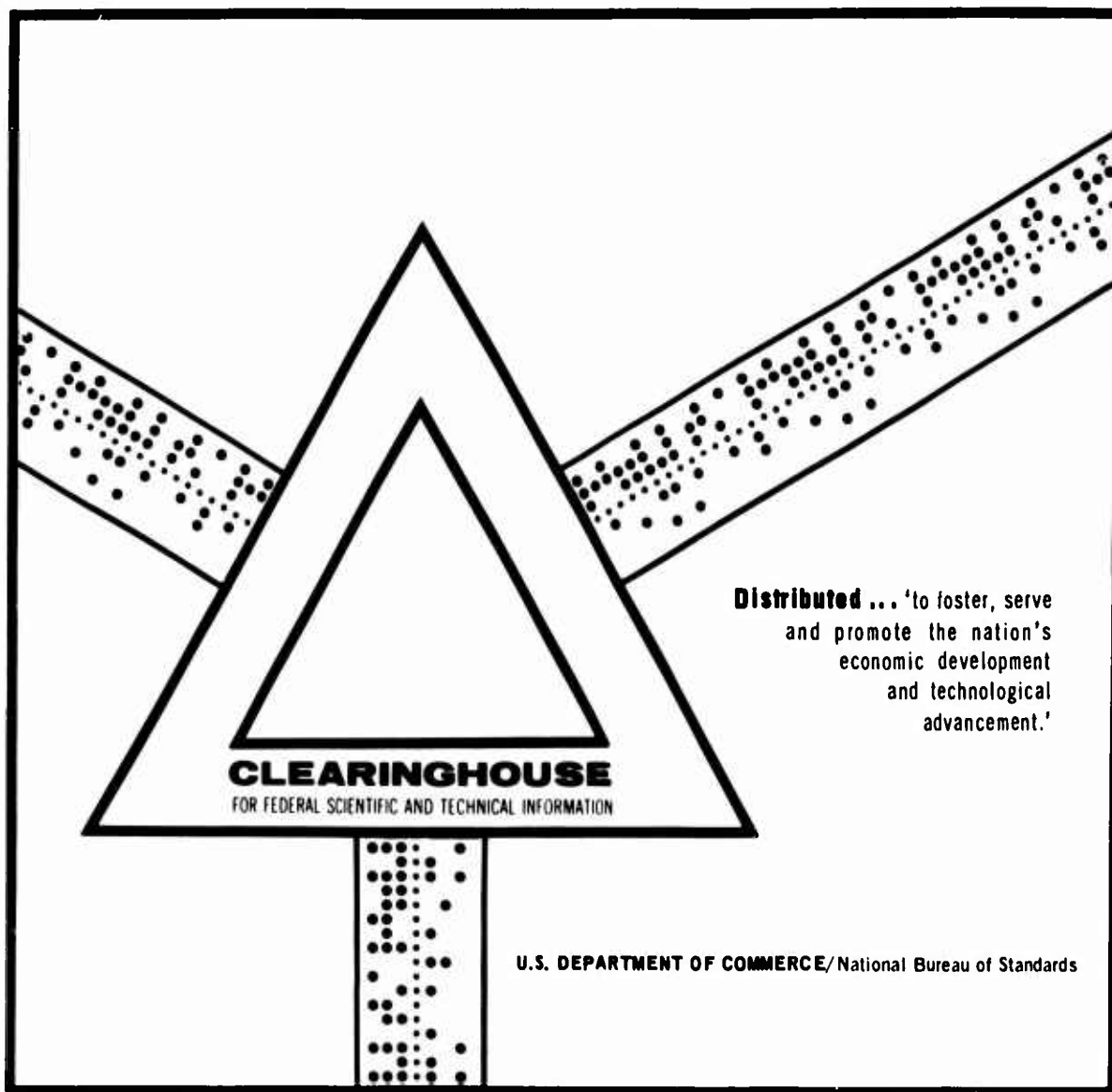
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REPEATING FUSELIGHTER

Imants Gulbis

Picatinny Arsenal
Dover, New Jersey

December 1969



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IMANTS GULBIS

DECEMBER 1969

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ABSTRACT

Explosive Ordnance Disposal (EOD) personnel must frequently initiate black powder time fuse when counter-charging for disposal and when using explosively actuated EOD tools.

A repeating fuselighter used as a supplement to the present M60 Igniter (single shot), would allow lighting many fuses in rapid sequence, and would reduce the total bulk and weight of M60 Igniters to be carried by EOD personnel, as well as effecting cost savings over the present system.

It would not replace the M60 Igniter in operations where waterproofing of the fuse end is required, as in underwater operations.

Two prototype repeating lighters (an electric and a percussion type) have been designed, fabricated and successfully feasibility tested.

It is recommended that one of them be developed into final militarized form and adopted. The choice would depend on specific requirements based on field survey of potential users in the EOD units.

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I

CONCLUSION

A rapid repeating igniter for black powder time fuse is feasible.

The most promising methods are percussion type, firing blanks or detonators, and electrically heated wire type powered by rechargeable batteries.

The main advantages of the percussion type are simplicity and ease of maintenance.

The advantage of the electrical type is relative silence of operation. (The only sounds involved in normal operation are the burning of the time fuse and the click of the heavy duty snap-action switch). The other methods tested were not found to be practical.

The miniature butane torch often melted the fuse covering prior to ignition of the black powder, preventing fuse ignition.

The compressed-air method, although useful for initiating enclosed propellants, was not feasible for time fuse due to critical sealing required to insure initiation.

II

RECOMMENDATIONS

It is recommended that a repeating fuse igniter be developed into final militarized form and adopted as a supplement to the single shot M60 Igniter. The choice between percussion and electrical type of fuselighter design should be determined by a survey of the potential users.

A percussion type of repeating igniter would be desirable for its simplicity. The use of the primers and many components from the present M60 Igniter (single shot) would lower costs, increase flexibility of use and the field availability of parts. Expendable plastic clips holding the primers would speed reloading and waterproof the primers.

The electric lighter should be considered for its silence of operation, which may be essential in certain kinds of covert operations.

III

BACKGROUND

The EOD mission requires detection, identification, field evaluation, rendering safe, recovery, evacuation and disposal of explosive ordnance which have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material as defined in AR 75-15. In many render safe and disposal procedures EOD personnel employ black powder time fuse to initiate specially designed explosive tools and charges.

The present lighter, "M60 Igniter, Time Blasting Fuse," is essentially a one-shot device. Although the M60 is technically reloadable, the disassembly, reloading and reassembly is so time consuming and intricate that battlefield reloading, (or even the reloading of a single igniter for consecutively lighting many fuses) is not practical. Presently, when several fuses are to be lit, the corresponding number of M60's are expended and usually discarded.

A repeating igniter would have the following advantages:

Cost Savings since the cost of the present M60 Igniter is about 73¢ each, (reference Army Supply Catalog SC 1340/98-ML, page 16), and the estimated cost of a repeating lighter is between \$10 and \$50 each. (100 lights at 73¢ each = \$73.00 for the M60).

Aid Logistics by decreasing the number of expendable igniters EOD personnel have to obtain and carry. In the field in Vietnam, for example, many EOD units are transported to site and subsequently resupplied by helicopter or airdrop, where bulk and weight must be kept to a minimum. Also, resupply in many areas is difficult, cutting down the availability of the M60's in quantity.

Allow greater flexibility of action by eliminating the need to closely predict in advance the number of lights needed. The bulk of the present M60 Igniter (single shot) discourages the carrying of many spares.

IV

CONCEPT

The goal was to investigate the feasibility of providing Army EOD units with a small, portable, repeating lighter for safety fuse to be used where weatherproofing of the fuse end is not necessary, and where a large number of consecutive lightings is anticipated.

The repeating method of use generally obviates the need for the clamping feature as found on the M60 Igniter (clamping feature could easily be added to the repeating lighter if desired).

The approach was to find probable lighting methods, prototype these methods, test the prototypes for feasibility, (i.e., does it light time fuse?), optimize the methods shown feasible, and retest the optimized models for relative merit.

The final issue item would be a compact kit (maximum volume of 18 cubic inches, 12 cubic inches desirable, for a minimum of 50 lights) containing the repeating lighter itself, with optional recharging materials depending on the design chosen. Maximum weight for a 50 light kit should be 3/4 pound, preferably 1/2 pound.

V

PROCEDURE

The percussion method ignites time fuse by initiating a small propellant charge near the end of the fuse. Figure 1 shows the prototype used for feasibility tests. The vertically moving clip holds eight 22 caliber blanks and is manually advanced with the thumb between firings. A spring detent holds the clip in position for firing. Operation involves pushing the fuse end into the projecting tube (which also serves as a noise reducer) with one hand and then pulling back and releasing the bolt handle with the thumb of the other hand. The bolt may be held in the cocked position (if desired) by moving the bolt handle into the side slot.

The clip is waterproof since a flexible plastic sheet was placed over the back of the clip before pressing in the blanks. The plastic sheet forms itself over the open end of the blank, forming a weatherproof seal. Weather proofing could also be accomplished by cementing a strip of thin aluminum foil over the holes of the clip after insertion of blanks or primers. The percussion lighter is waterproof.

An effort to reduce the noise of operation showed that the best approach was to confine the resultant gases by having the fuse inserted into the lighter through a close fitting tube (about .22" I.D.) of 1/2" to 1" length.



FIGURE 1
Percussion Lighter

It is recommended that a final version of the percussion lighter use the same primers, striker head, spring, and be made of the same material (nylon) as the present M60 Igniter. This would (a) lower overall costs, (b) increase field availability of the primers and spare parts, (c) decrease development time and costs by using many proven components and materials.

The clips should be molded (nylon) and disposable after firing, with the fuselighter body also disposable after all the clips in the issue kit are expended. A plastic clip holding up to ten primers would still take up only 1/3 as much space as a single one shot M60 Igniter.

The electric method ignites time fuse with an electrically heated resistance wire powered by rechargeable nickel-cadmium batteries. Figure 2 shows the prototype used for feasibility tests. The lighting head is machined from asbestos-filled phenolic and has a hole for the insertion of the fuse end. An intersecting slot holds the resistance wire across the fuse hole, ensuring proper positioning and contact with the fuse. (The asbestos-filled phenolic proved to be highly resistant to burning time fuse). The phenolic lighting head also serves to shield the hot wire from ambient wind, which on a cold day can cool the wire below the lighting temp of 1600°F.

The "knife-switch" type clips at each end of the slot hold the resistance wire in position and provide electrical contact to the battery through the push-button switch. The clips and the open wire slot allow rapid replacement of the resistance wire. Replacement wire is wound around the base of the lighting head. The body of the prototype illustrated in figure 2 contains a 2.3 ampere-hour, nickel-cadmium battery, a half wave rectifier and inductive battery charger, and a heavy duty (10 amperes D.C. rating) momentary contact switch. Operation involves pushing of the fuse end into one of the two holes in the lighting head and pressing the switch until smoke issues from the opposite hole.

When the resistance wire burns out (after 10 to 50 lights depending on ambient temperature and humidity) a new length of wire is uncoiled from around the head and drawn between the two clips. The prototype is designed for ten lightings between wire replacements.

It is recommended that a final version of the electric fuselighter incorporate 12 volt D.C. charging capability (from vehicle batteries)



FIGURE 2
Electric Lighter

along with the 117 VAC charging mode, as shown in the schematic figure 3. A diode bridge is used to make the D.C. charging contacts insensitive to polarity of connection to (+) or (-) battery terminals. A heat-dissipating resistor (10 watt rating minimum) is used to bring the charging current down to the value specified for the battery. (The correct charging current is usually 1/10 of the ampere-hour capacity of the nickel-cadmium battery). Figure 4 shows the proposed arrangement of internal components.

Initial feasibility testing was performed on a commercially purchased fuselighter which was essentially a modified electric cigarette lighter. Although the commercial lighter lit fuse consistently, it fell far short of being field usable. The commercial lighter also required replacement of the hot wire element about every ten lightings. This lighter used plug-in modules to replace the element (as 50¢ each) requiring a large bulk of replacements to be carried along. The wire used was a Platinum-Rhodium alloy which was expensive (\$3.75 per foot plus \$100 tooling charge) and required about a one month lead time on special order. The prototype lighter shown in figure 2 uses a special Nichrome alloy formulated for resistance to carbon embrittlement and which stood up as well or better than the Platinum-Rhodium alloy in extensive tests. (Carbon and Sulfur embrittlement appears to be the main cause of element failure when lighting black powder type time fuse). This Nichrome wire is very cheap (\$5.00 for about 1,000 feet) and is widely available from commercial stocks.

Although recommended by the manufacturer for 117 VAC charging the commercial lighter used a capacitor (Siemens B32231, 2.2 K250) rated for only 90 to 100 volts A.C., thus greatly lowering overall reliability. An extensive search for commercially available capacitors with an adequate rating and capacity failed to turn up any U. S. made items small enough to fit into a hand-held tool. An inductive system was finally chosen despite higher weight and cost. The commercial lighter also utilized an open contact switch surrounded by fiber packing, which could easily work its way between the contacts preventing contact when dry and shorting them when wet. The switch also progressively deformed with use until no contact could be made. A sealed, snap-action, momentary-contact switch was selected for the prototype, having a 10 ampere D.C. contact rating. Switching of D.C. currents is much more critical than switching A.C. currents of the same effective amperage.

SCHEMATIC: FUSELIGHTER, ELECTRIC, RECHARGEABLE

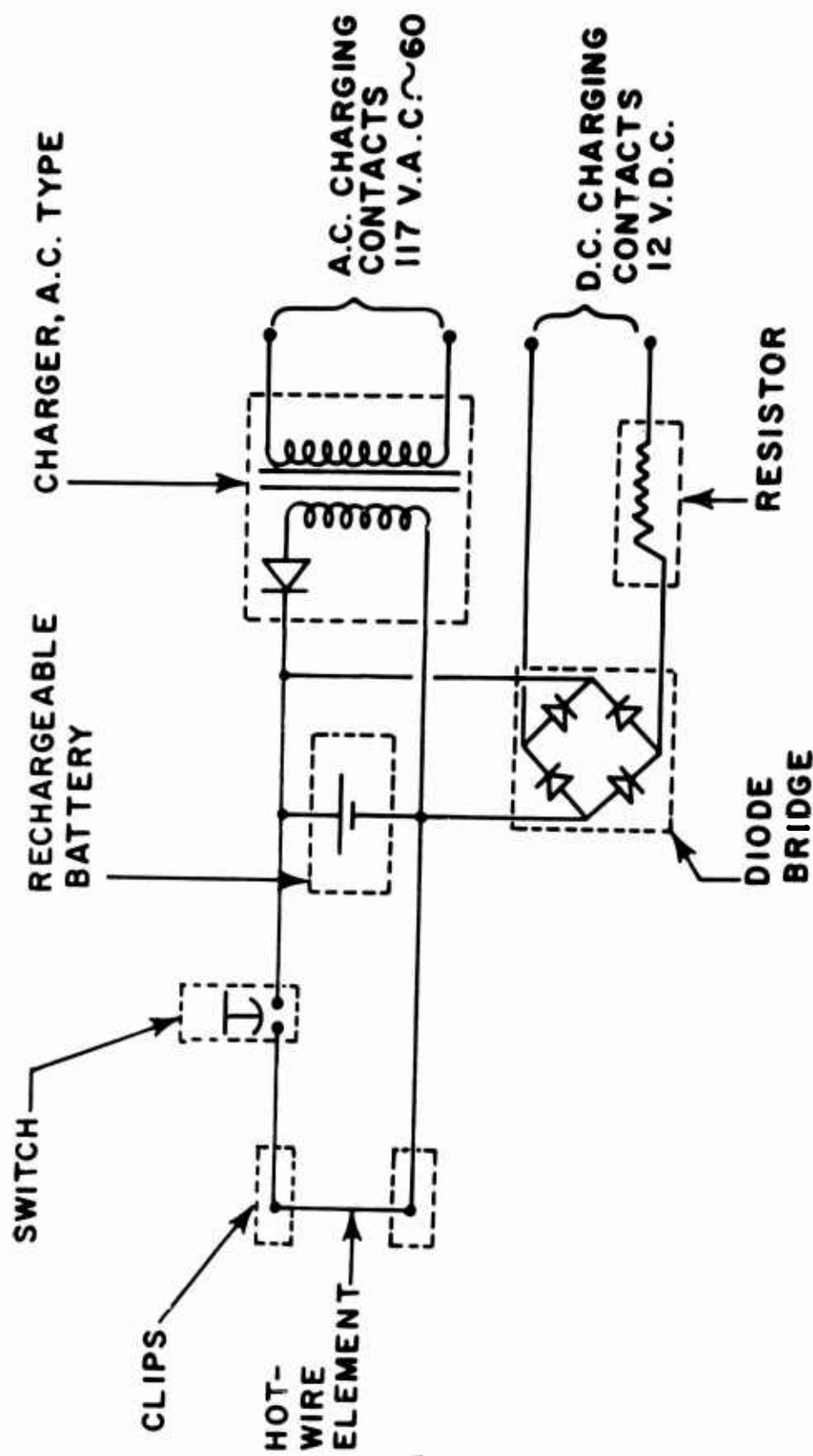


FIGURE 3

ELECTRIC FUSELIGHTER

COMPONENT ARRANGEMENT

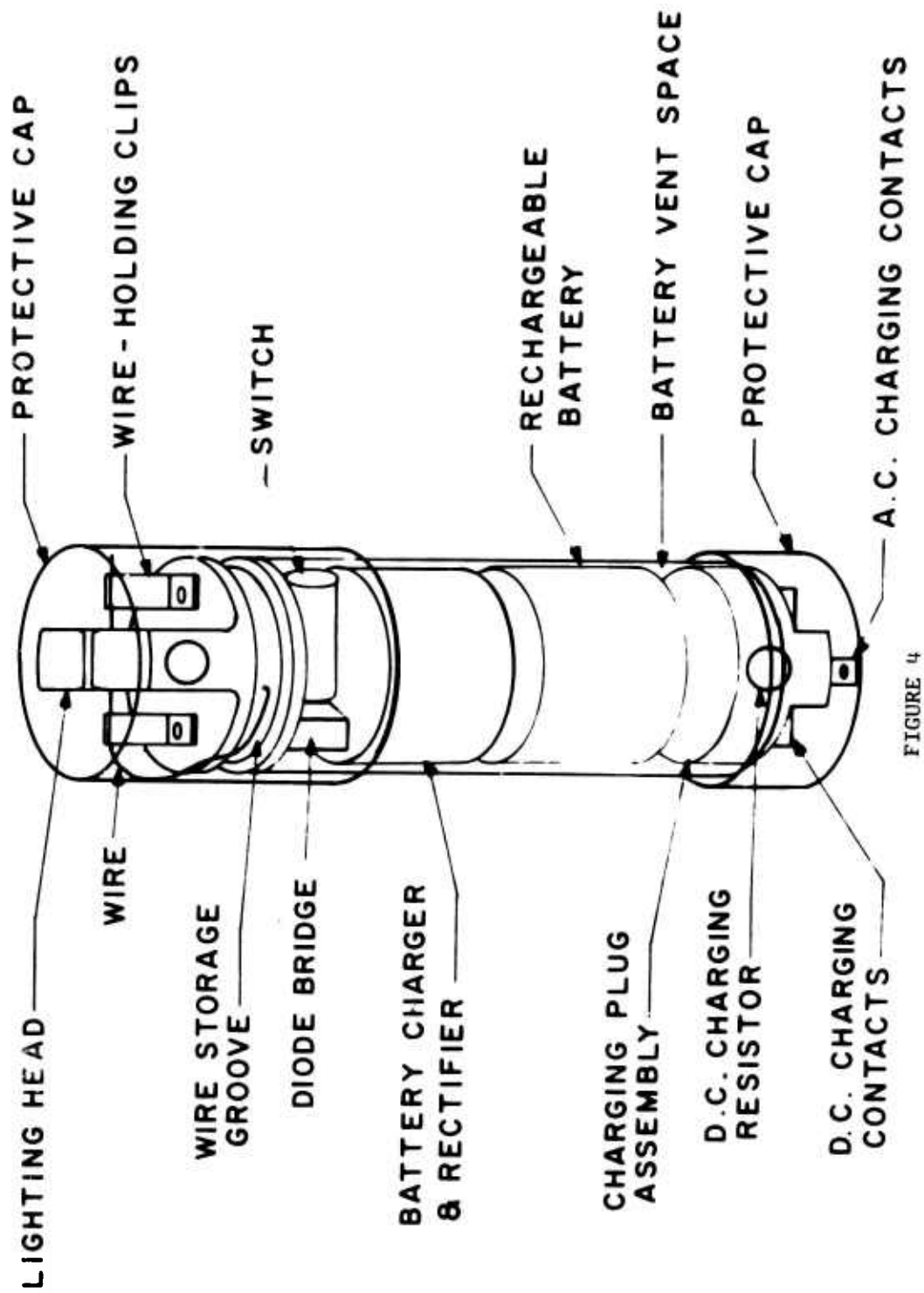


FIGURE 4

It was not possible to "pot" (seal in rubber or plastic) the battery and attached wiring in the prototype because all commercially available Nickel-Cadmium rechargeable batteries must be vented during charging to prevent possible explosion.

Another problem characteristic of rechargeable Nickel-Cadmium batteries is the difficulty of determining the amount of charge in the battery at any particular time. In use the electric lighter would have to be kept on constant charge until needed to insure the required number of lights.

In a final version of the electric fuselighter the charging circuitry could be enclosed in a separate plug-in module from the rest of the fuselighter. This would allow the operation of several fuselighters with a single charging module.

Feasibility tests were run of the air compression method of initiating time fuse, using the modified chamber and initiator section of a Daisy "VL" rifle, as shown in figure 5.

The test results indicate that a very tight seal of the firing chamber is required for initiation, and that when ignited the propellant burns too rapidly for use as a time-delay. The high degree of sealing required would be impractical on the hollow time fuses now in use, as shown by some tests where the pressure pushed the black powder part way down the length of the fuse without igniting it. This method would be better suited for the initiation of enclosed propellant or explosive trains as found in ordnance fuzes. Figure 6 shows the operating principles of the Daisy "VL" rifle's compression ignition section.

Feasibility tests were also performed on the use of a miniature butane-oxygen torch for lighting time fuse.

The test showed this method not to be feasible because the heat of the flame caused the outer coating to melt over the end of the fuse before the black-powder core could ignite. Cutting a portion of the fuse end lengthwise usually allowed ignition, but the extra manual operation negated the advantage of a rapid repeating lighter, especially when compared to the previously mentioned methods.

VI

EVALUATION

Both the percussion and electrical types of fuselighters are feasible for final development into a rapid repeating fuselighter.

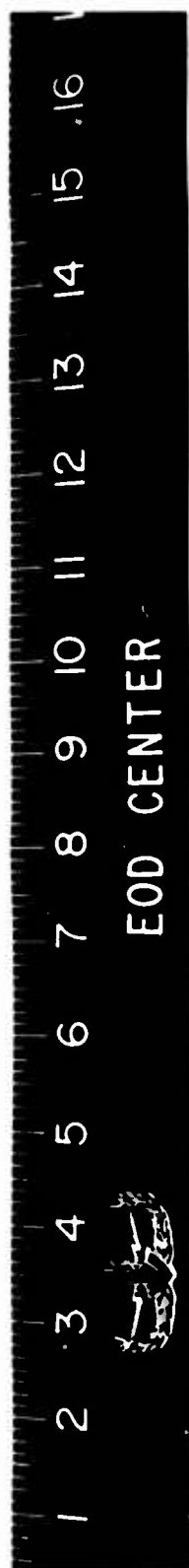
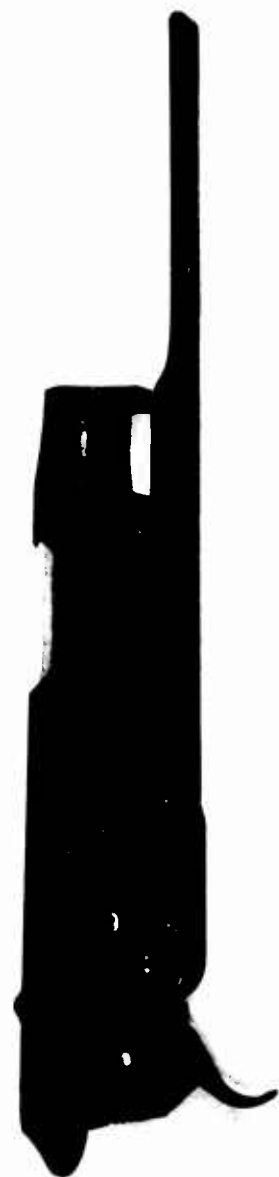
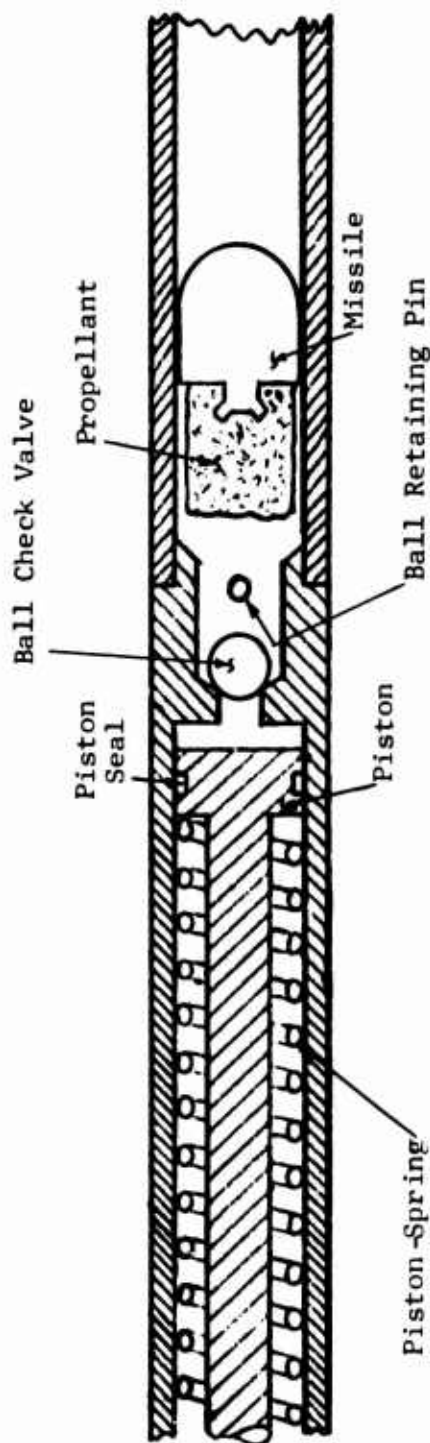


FIGURE 5
AIR COMPRESSION IGNITER
(Modified Chamber and Initiator Section of a Daisy "VL" Rifle)



When the trigger is pulled it releases the piston, which is driven forward by the piston-spring and rapidly compresses the air in the cylinder. The rapid compression causes an extreme rise in the temperature of the air, which is forced through a small hole and around a ball check valve. The jet of heated air ignites the propellant attached to the missile. The propellant is consumed in the firing chamber.

FIGURE 6

Compression Ignition Section. Daisy "VL" Rifle.

The percussion method has the advantages of simplicity. The electric method has the advantage of a quieter operation. However, before conducting a final evaluation of the electric lighter against the percussion type, an attempt should be made to decrease the noise level of the percussion type. The tight fitting tube used on the last percussion lighter lowered the noise level considerably when compared to the first tests.

A rapid-repeating fuselighter would be an excellent supplement to the present M60 Igniter.

Both the electric and percussion prototype fuselighters were demonstrated by Mr. R. Jordan of EOD Center on 28 September 1968 at the briefing for USACDC Institute of Strategic and Stability Operations, Fort Bragg, North Carolina. Although the items seemed to be favorably received, no requirements were forthcoming.

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